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AUTHOR Costa, Crist H.
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ABSTRACT

A set of procedures were developed which assist in structuring tasks and objectives in a manner to permit rational decision making. The model uses a jury of experts to rank various objectives and program processes in terms of their importance. Values are generated which relate to costs in the form of a utility-cost ratio. The model was tested in a small, midwestern urban school district. Various decision makers were interviewed to ascertain their perception of the utility of the model. The model is extremely practical in terms of ease of use and ability to structure program components into a setting for decision making. (Author)

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Cost Utility: An Aid to Decision Making

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Crist H. Costa

Center for Evaluation and Research

Rhode Island College

Providence, R.I. 02903

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Introduction

The availability of federal funding for the development and implementation of different and sometimes unique instructional programs has appeared to be somewhat of a mixed blessing. Without such resource incentive, it is possible, if not probable, that the emphasis on structured planning and evaluation of such programs would not have been present. A comparison of a school district's local expenditure for planning and evaluation activities versus the expenditure of federal monies for evaluation or formalized planning activities will most likely support my contention. Given the vast amounts of time and the related expense involved in the myriad of activities necessary to develop a sound plan, and then the paperwork and time needed to effectively monitor the implementation of the plan, it is no wonder that local school administrators are asking for some relief from the time consuming planning tasks. Unfortunately, the shrinking resources and the increased inflation, demand more and better planning rather than less. Tools are needed to aid local school decision makers in their deliberation.

This paper will review some of the shortcomings identified with the formalized planning and evaluation systems presently in existence. It will also review some of the forgotten assumptions supporting the development of these systems. It will review some of the proposed models for the evaluation of programs in terms of costs. Finally it will propose two models which because of their simplicity could be of benefit to the educational decision maker who does not

have economists, operations researchers, and the like on his planning staff.

Evaluation

It is of no surprise, to be told that many programs lack clear objectives upon which to base an evaluation design. Provus (1971) as well as most authors on this paper's reference list all identify the lack of clear program objectives, and clear descriptions of program processes as hampering the evaluation of the program. Guba (1969) elaborates on the shortcomings of elaboration and cites the following "lacks":

1. Lack of adequate definition of evaluation.
2. Lack of adequate evaluation theory.
3. Lack of knowledge about decision processes.
4. Lack of criteria.
5. Lack of approaches differentiated by levels.
6. Lack of mechanisms for organizing, processing and reporting evaluative information.
7. Lack of trained personnel.

Walberg (1970) cites the influence of Ralph Tyler's writings on educational evaluation, the controversy on objectives, the problem with programming, the inconsistency of educational research to identify learning experiences which work for all students, the lack of generalizability of evaluation, and the need for a more useful evaluation.

New books by Provus (1971) the Phi Delta Kappa National Study Commission (1971) and others, are attempts to eliminate these evaluation shortcomings previously cited.

Decision making

The Phi Delta Kappan National Commission (1971) defined evaluation as the "process of delineating, obtaining and providing useful information for identifying decision alternatives." One of the difficulties with providing decision alternatives for decision makers, is that the decision making settings are frequently too poorly defined. In this era of emphasis on management information systems, this can result in a decision maker receiving reams of computer generated data but precious little decision making information. Ward and Lehman state (1972) "The point is that decision levels must be served with information that applies to each level, but previous to now a suitable process for describing decision settings has not been formulated."

Eight years earlier, Dill's (1964) chapter in the 1963 NSSE Yearbook cites the following quotations:

The task of "deciding" pervades the entire administrative organization quite as much as the task of "doing". The central function of administration is directing and controlling the decision-making process. The executive is a decider and not a doer.

Dill's entire chapter emphasized the increased attention given by specialists in administration to the art or science of decision making. He indicated that most research revolved around finding answers to three questions: How are decisions made? Who should make decisions? How can we make better decisions? It is the last question--How can better decisions be made?--that the major part of the paper will be addressed.

P.P.B.S.

Kershaw and McKean (1959) after studying the potential for using systems analysis techniques in education summarized:

After having studied the educational process, the problems of measurement, and the data that are becoming available, we conclude that it will soon be feasible to make comparisons of this sort that can help administrators and others choose improved educational systems. It will be necessary first, however, for more work to be done toward estimating the "input-output relationships" in education.

From early observations such as this and the expanded use of PPBS in the government and defense industries, come similar proponents in education. Hartley (1968) is the more common proponent but Banghart (1969) and Van Dusseldorp (1971) also encourage its adoption through the umbrella term of systems analysis. Alioto and Jungherr (1969) indicate the reason for their district going to PPBS in their article entitled "Using PPBS to Overcome Taxpayers Resistance." Specific advantages to the particular PPBS proposed by their district or committee can be found in articles by the Trenton Public Schools (1971), Western New York Study Council (1969) and National Committee on Educational Finance (1968) to name a few. A more complete review can be had through the use of the AASA (1970) Collection of Abstracts entitled "A Collection of ERIC Documents Resumes on Program Budgeting and Cost Analysis." An article by Bibbs, Rath and Kent provides some insights gained by the Skokie School district after one year's experience with P.P.B.S. .

It is the introduction and use of P.P.B.S. which has brought the terms cost effectiveness, cost benefit analysis, cost-utility, utility-cost ratios to the forefront of educational publi-

cations. In fact, it is the ability of planning systems such as PPBS and its structured attempts to link costs with programs, and programs with specified desired outputs that makes PPBS so attractive to school administrators. With the current demand for a visible accounting of educational outputs for the budgetary inputs, planning systems which automatically provide information about program outputs are regularly being sought. Unfortunately, PPBS, and its associated cost effectiveness analysis or cost benefit analysis, will not serve as a miracle elixir to cure poor decision making. If used for unintended purposes or in unintended ways, it may help to make poorer decisions.

Kaufmann (1968) identifies some serious misconceptions about cost-benefit analysis. Some of these shortcomings are cited below with a short comment by this author for clarification:

1. "It is merely a subterfuge for seeking to conduct education on a least-cost basis." Proponents of cost-effectiveness analysis usually seek efficiency of operations so that the savings could be applied to other educational needs for which funds are lacking.
2. "Some things can't be measured." Maybe so, but if the benefits of the program cannot be described in some substantive way, how will people decide if they wish to spend more money to support it.
3. "The cost benefit analysis ignores the political factors." This isn't true. In fact, it can help to identify the costs of making so-called political decisions.

Furno (1969) agrees with the potential of PPBS and the associated cost analysis, but cites many of the forgotten shortcomings, the largest of which is the data collection, organization, and utilization. He cites the need for a very sound position control system to support the financial information system, and remarks about the lack of such systems in the major cities where the largest benefits of such cost analysis could be accrued.

Cost-Effectiveness Analysis

Much of the difficulty surrounding the use of cost effectiveness analysis lies with the lack of clear definitions as well as satisfactory methods of measuring costs and benefits. In the review of literature cited by the Western New York School Study Council (1969) the only stated difference between cost-benefit and cost-effectiveness analysis, was the choice of output under scrutiny. If the program's benefits could be converted to dollar terms, it was considered to be cost-benefit analysis. If the benefits could not be so converted, the analysis was considered to be termed cost effectiveness.

The workshop reported by McAbee (1968) offered the following definitions:

Cost Effectiveness is the cost per program unit produced.
Cost Benefit is the relationship between the cost of the product and value of the benefit of producing it.

Davie (1965) identified some other limitations in the use of benefit-cost analysis. One was the dilemma of considering a program's value from only a local viewpoint since it may conflict with the value of a larger reference group. Another interesting problem

is due to the differing values which people place on money. The subtle semantic difference of labeling something an educational "investment" versus an educational "expenditure" implies this difference in attitude toward the value of money. Welty's (1971) paper describes different types of cost-benefit analysis in terms of the way in which the analysis is structured. He describes those studies relating historical data on costs and estimated benefits via some type of multi-variate analysis as descriptive cost-benefit analysis. The other types of studies might be labeled as structural or experimental cost-benefit depending upon the development of the production function under consideration. Despite the various identified shortcomings, more and more articles are being written about the advantages of cost benefit analysis and cost effectiveness analysis. A review of cost-benefit--PPBS literature frequently finds Quade's (1965) article on Cost Effectiveness cited. His earlier observations are still pertinent. He first identifies the five elements of analysis which are: the objective; the alternatives; the costs; the model; and the criterion for measurement. His comments on costs are most appropriate for he states:

In analysis for a future time period, most costs can be measured in money, but their true measure is in terms of the opportunities they preclude.

It is this equating of lost opportunities to costs, which introduces a difficult conceptual problem for the users of cost effectiveness analysis. The models identified in the last portion of the paper try to bridge this gap with the use of utility measures. Quade's other observations deal with the caveats of analysis.

They are:

1. All analysis is necessarily incomplete due to time and money constraints. Frequently hindsight can make what was originally a good decision appear to be a bad decision.
2. Most measures of effectiveness are approximate and in fact the cost measures are frequently estimates also.
3. No satisfactory way to predict the future exists and so any estimate of optimum policy can only be in terms of the best guess as to what the future holds.
4. All analysis of choice falls short of scientific research. Human judgment is used in designing the analysis; in deciding what alternatives to consider, what factors are relevant, what the interrelations between the factors are, and what numerical values to choose; and in analyzing and interpreting the results of the analysis. This fact that judgment and intuition permeate all analysis should be remembered when we examine the results that come, with apparent high precision, from analysis.

With Quade's cautions in mind, an increasing number of individuals have been looking at the educational process and trying to develop models which are appropriate for evaluating educational programs in terms of cost and effectiveness. All of the studies are attempts to provide a decision maker with better information than is currently held. Temkin (1971) has proposed the use of a tool or unit which he calls the Elasticity of Cost Effectiveness. Abt (1966, 1969) cites approaches taken in the evaluation of Indian education programs, and in the analysis of Title I ESEA projects. Stormsdorfer (1972) and Davie (1965) have used cost effectiveness analysis models for the evaluation of Vocational Education projects. Webster (1972) uses cost-effectiveness at its simplest level of analysis in her comparison of reading programs in terms of their

costs to produce 0.1 unit of gain in reading achievement. Cleckner (1971) offers a critique of five different models and proposes changes which can eliminate his identified shortcomings. Badran (1970), Harmon (1970) and Mood (1967) offer general comments on the worth of cost effectiveness analysis and offer approaches to be utilized in carrying out such analysis. Chuang (1972) describes a planning system designed to convert broad statements of goals into more refined decisions within a budget context. Haggart (1971) proposes a variety of suggestions regarding the costing of programs, though her earlier work with Carpenter (1970) is an excellent introduction to the use of cost effectiveness analysis in education. It is the work of researchers such as these which has continued to provide assistance to educators who must make decisions. Decision making is seldom easy, and the information to support the decision even more difficult to obtain. It is the belief that better information, provided in a planned setting, will permit more rational and hopefully better, decisions, that prompts the recommendation of cost-utility analysis as an aid to decision making.

Present Model Shortcomings

The previous pages have provided a cursory review of the literature relative to P.P.B.S., decision making, evaluation, and particularly to cost effectiveness analysis. While the shortcomings of cost effectiveness analysis have been identified, it is hoped that the positive potential benefits are still apparent. The one drawback to many of the cited models, is their need for a team

of analysts to be present on school superintendents' staffs. If P.P.B.S. and its associated cost analysis is to become more prevalent in school system decision settings, it will have to become somewhat easier to use by the staff already present. Increases in administrative staff tend to be difficult to obtain during times of financial pinch. The two models about to be described, represent what might be described as tools which could be used by most any school administrator and his present staff when faced with choosing between alternative programs designed to meet equivalent goals. The models were chosen for their relative ease of computation, lack of confusing jargon, and yet still able to provide valuable rational decision making.

Tanner's Model

The first model is one proposed by C. Kenneth Tanner (1971) in his text Designs for Educational Planning. The article by Hughes and Tanner (1970) provides a case study of this model in use. No attempt will be made there to discuss the model in its entirety, but rather to identify its highlights and in turn its value in decision making.

Tanner's model attempts to incorporate the use of subjective judgments about a program's worth. He suggests a Bayesian approach which will utilize all of the information known about the program to yield a series of values which are probabilities of the program's future worth and can also serve as a baseline for measuring the program's worth at a later time. Tanner (1971) very carefully lists all of the assumptions he has made regarding the use of the model.

Some of them--such as, the program elements are agreeable to the formulation of clear, concise, measurable objectives and the unit cost of each program element can be determined--are the same kinds of assumptions found with any model of this type. The assumptions do not seem to limit the value of the tool.

Tanner's model is described in more detail in his text, but the following steps should provide some idea of its formulation and use. When following along, one should assume that the planner using the tool wishes to assess the future effectiveness of a program consisting of ten courses, and in particular, identifying the most effect course of the ten. In addition, assume that the students' success in each course is reflected by the number of objectives completed in that course, and that these success scores have been collected by the planner.

Step One Determine the percent of behavioral objectives achieved for one program element or course.

Step Two Determine what the value judgments, regarding the general program objective, were per program element. These judgments might come from the participants, the teachers, some panel of experts, etc. and the judgments are to be captured via some attitudinal instrument.

Table 1

Future Program Utilities Based on the Initial Sample

Program Element (Course)	Prior Distribution (Values from Step 2)	Sample Distribution (Step 1)	Joint Probabilities (Step 1 x Step 2)	Posterior Probabilities JP_1 / JP_1
1	.042	.894	.036	.041
2	.145	.916	.133	.152
3	.048	.832	.040	.046
4	.073	.896	.065	.074
5	.091	.980	.089	.102
6	.109	.935	.102	.116
7	.127	.769	.098	.112
8	.152	.799	.121	.138
9	.048	.749	.036	.041
10	.164	.950	.156	.178

The purpose of using this Bayesian approach is to determine the utility (worth) of a given program element within the group of ten elements. The Bayesian posterior probability distribution serves as an estimate of future program worth or utility. It is important to note, that this utility value was achieved by combining attitudinal judgment about each program's element (Column 1) with observed quantitative data about the program's worth (Column 2).

Step Four Integrate the program element costs with the calculated utilities. This is done by calculating the conditional worth per program element which is defined as the absolute difference between the standardized cost of that program element and the selling prices of the other elements. Naturally the program costs will have to be standardized in some manner as to permit valid comparisons. Since public education is not expected to operate at a profit, it is assumed that selling price and cost are equal on any given program. Table 2 (Tanner, 1971) shows the conditional worth calculated for program element 1. The same calculations would be performed for all 10 elements.

Table 2

Conditional Worth of Program Element 1			
Program Element	Selling Price	Cost of 1	Conditional Worth
1	18	18	0
2	21	18	3
3	18	18	0
4	17	18	1
5	23	18	5
6	14	18	4
7	26	18	8
8	19	18	1
9	22	18	4
10	23	18	5

Step Five Calculate the expected opportunity loss, which is the sum of the products of the utilities and the conditional worth per column per program element. Table 3 represents the calculations necessary to find the expected opportunity loss related to the choice of program alternative 1.

Table 3

Expected Opportunity Loss for Program Element I

Program Element	Utilities	Conditional Worth of Element I (dollars)	Expected Opportunity Loss (utils)
1	.041	0	0
2	.152	3	.456
3	.046	0	0
4	.074	1	.074
5	.102	5	.510
6	.116	4	.464
7	.112	8	.896
8	.138	1	.138
9	.041	4	.164
10	.178	5	<u>.890</u>
Total			3.592

Table 4 reflects the total loss for the entire program.

Table 4
Expected Loss for Total Program

Program Element	Expected Loss (utils)
1	3.592
2	2.806
3	3.592
4	4.212
5	3.156
6	6.516
7	5.484
8	3.146
9	2.980
10	3.156

One should note that the value of the Expected Loss represents a combination of the utility of the program and the relative costs of the program as reflected in its conditional worth. In addition, it should be evident that in most cases, the optimal program choice is that which provides the least expected loss.

This very brief explanation in no way does full justice to the Bayesian model proposed by Tanner. It is presented only to provide a glimpse as to its ease of use and genuine worth in terms of its ability to aid decision making.

Milwaukee Model

The second model being proposed is similar to the first in its attempt to take advantage of orderly opinion about program worth. This model is explained more thoroughly in Costa and Giroux (1971) and the Association of School Business Officials' final report. As in the previous example, the main purpose is to give a general idea as to the model's workings and to highlight its ability to aid decision making. The model assumes that enough is known about the project such that measureable objectives can be created which will serve as indicators of the project's purpose. Furthermore, the activities within the program can be categorized into unique processes. Frequently, these processes will be input oriented, such as the use of a teacher's aide as a tutor, or the use of a particular set of instructional materials. The model is designed to assist the decision maker in identifying the most important objectives of the program, the

most important processes in the program, and the perceived relationships between the two. In addition, it also provides for the introduction of standardized cost data to develop utility/cost ratios for the purpose of identifying the economic and value consequences of various process choices. This approach should be most beneficial in situations where whole program are not about to be discarded, but rather selective modification will be used prior to refunding of the program.

The steps involved in utilizing such a model is as follows:

Step 1 In some structured way, select a jury or panel of experts capable of making informed judgments about the program. In some cases, this jury may include program participants themselves.

Step 2 Each jury member is then asked to rank each of the objectives in terms of their importance. Importance is defined as the degree to which the jury would like to see the objective achieved at the termination of the program.

Step 3 Calculate the mean rank for each objective by summing the ranks and dividing by the number of rankers for each and every objective. Should there be great variance of opinion on any objective, the planner may wish to use some consensus forming strategy such as the Delphi method to reduce the variance.

Step 4 The objectives are then rank ordered in terms of their mean rank. In addition, each objective is given a weighted value of importance equal to the inverse of its rank. An objective ranked tenth in a group of ten objectives would be given a

weight of one (1).

Step 5 Have each jury member rank order the processes in terms of each objective.

Step 6 Sum the ranks for all processes for all objectives. Let

$S_{R_i O_j P_j}$ equals the score or rank given by ranker i on process j for objective k.

Step 7 The proportion of contribution that a process makes toward the attainment of a particular objective is equal to the total score of a process for an objective, attained in step 6, divided by the sum of the total scores for all processes for that objective. If there are q rankers, m objectives, and n processes,

then the proportion of contribution that process 1 makes to the achievement of objective 1, equals $\sum_{i=1}^q S_{R_i P_1 O_1} / \sum_{i=1}^q \sum_{j=1}^m S_{R_i P_j O_j} = P.C.$

Step 8 Calculate the utility value of each process. Utility is defined as the degree to which a process is perceived to contribute to the attainment of an objective or objectives. The utility value of each process is considered to be a function of how much that process helps to accomplish each objective and the relative importance of the objective. In other words, the process with the highest utility value is that process which contributes the most to achieve the most important objective.

$$\begin{array}{l} \text{Utility Value of} \\ \text{Process 1.} \end{array} = \sum_{k=1}^m 100x \begin{array}{l} \text{(proportion of contribution} \\ \text{of process 1 for Objective k} \\ \text{Weight Value of Objective k)} \end{array}$$

Usually the value inside the brackets is multiplied by 100 so as to deal with whole numbers.

Step 9 The utility/cost ratio for each process is equal to the utility value of the process divided by the standardized cost for the process.

As with the previous model, this short explanation of the models' working does provide the complete explanation it deserves. In addition, this short explanation did not identify the limitations inherent in the model. As stated in the introduction however, no model is without some limitations, and so whatever benefits these two approaches might offer local school decision makers, should be investigated and considered for adoption if appropriate.

Hopefully what is evident in both models, is a structure which allows for rational systematic program analysis and its subsequent aid in decision making.

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